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ABSTRACT

This study presents evidence that differences in mathematical career outcomes of males and females are the result of early socialization in the family. One reason fewer females than males elect to take high school mathematics courses is that during middle school years females perceive low parental evaluations of their mathematical aptitude and develop low self-concepts of mathematical ability. Traditional independent variables, intelligence quotient (IQ) and socioeconomic status (SES), do not explain the behavioral difference between the sexes in higher mathematics. Data are taken from a longitudinal study of 588 students in grades 8-12. Data analysis is based on path analysis models and tables of percentages which describe differences between males and females. Tables present information on completed mathematics courses, perceived parental evaluation of mathematical ability, and self-evaluation. Three intervening variables are examined for path analysis: sex, IQ, and SES. Path analysis indicates that the intervening variables, perceived parental evaluations, and self-concept of mathematical ability are strongly correlated with subsequent behavior. That is, females are programmed by both parents and themselves for lower performance in mathematics than males, and they subsequently behave according to the self and parental concepts. Implications for social change are considered. (Author/ND)

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Why Females Don't Like Mathematics: the Effect of Parental Expectations

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ABSTRACT

Why Females Don't Like Mathematics:
the Effect of Parental Expectations

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This study presents evidence that differences in career outcomes of males and females is the result of early socialization in the family. One of the reasons fewer females than males elect to take high school mathematics courses--an important pre-requisite for entry into many careers--is that during their middle school years females tend to perceive low parental evaluations of their mathematical apitudes and thereby develop low self-conceptions of mathematical ability. Traditional independent variables, IQ and SES, do not explain the marked behavioral difference between the sexes in higher mathematics. Path analysis indicates that the intervening variables, perceived parental evaluations and self-concept of mathematical ability are strongly correlated with subsequent behavior--females being "programmed" by both parents and themselves for lower performance in mathematics than males, and subsequently behaving consistently with these self and other concepts. The data were from a longitudinal study of a cohort of 500 students in the junior and senior high grades. Implications for social change are considered.

Proportionately, far fewer women than men enter careers requiring advanced mathematical skills. This is one consequence of the high school experience where, for example, fewer females than males take courses in mathematics. This research presents evidence that one of the reasons fewer females than males elect to take mathematics courses in high school is that during their earlier middle-school years these females tend to perceive lower parental evaluations of their mathematical aptitudes than do their males counterparts; i.e., females tend to suffer from stereotypes held by their parents.

In examining high school or college differences between males and females in mathematics, one might mistakenly conclude that males are superior in some basic mathematical aptitudes. However, many studies have shown that in the elementary and middle school years, females consistently received higher grades for mathematics achievement than males of equal intelligence levels (Lewis, 1968).

A number of studies have tested the mathematical abilities of students at various ages and grade levels and have concluded with few exceptions that only after a certain grade--the seventh grade--do boys tend to attain greater mathematical skills than that shown by girls (Hilton and Berglund, 1974; Maccoby, 1966; Forbes, 1975). With few exceptions, most studies of elementary students find no significant differences between the sexes in mathematics. (For literature reviews see: Fennema, 1973; Maccoby, 1966; Jacklin and Maccoby, 1972; and Kaminski, 1974).

However, during high school another picture emerges. In fact, the study of ninth grade students by Sheehan (1968) seems to be the only study which found girls to be slightly superior in one area of mathematics--this was in the problem solving area. Males appear to be clearly superior in mathematical reasoning in high school and this superiority continues for those attending college (See for example: Flannigan, et.al., 1964; Rosenberg and Sutton-Smith,

1964; Rossi, 1969; and Kaminski, 1974.) According to Bem and Bem (1970), men score about 60 points higher than women on the mathematics section of the College Board examination. It also appears that men score higher than women on the mathematics portion of the Graduate Records Exam, another instrument for screening students into or out of advanced career levels (Osbourne and Sanders, 1954).

Caution should be used in interpreting these emergent sex differences in mathematical ability in the high school years and beyond. The populations from which the two averages are typically obtained are not always validly comparable once students have reached the age at which they tend to disproportionately drop out of school. It has been generally found that more males than females drop out of school; that males drop out earlier than females; and that more lower ability than higher ability students drop out. Hence, the female average in mathematics may be low in high school and beyond because its population includes more of the low ability students, whereas the male counterparts of some of these low ability females have dropped out and are not included in the male average. One must also consider that in general, the more mathematics classes one takes in high school, the better one will do on ability tests in mathematics at that level and beyond. Hence, some of the variance between male and female mathematical ability in high school and beyond is accounted for by their differences in preparation.

In other words, the sex differences in mathematical abilities which have traditionally developed during the high school years provide a false basis for the stereotype that women are incompetent in mathematics. Contrary to such false stereotypes, many women are competent in mathematics as might be evidenced by the U. S. Office of Education's Findings for 1970: while women earned 43% of all Bachelors degrees that year, they earned 38% of the mathematics degrees at

this level; at the Masters level, women earned 40% of all degrees, and 29% of all mathematics degrees; at the Doctoral level, women earned 14% of all degrees and 8% of the mathematics degrees. Even so, there are emergent differences.

What are the reasons for these emergent differences in mathematical skills between the sexes? Focusing on cognitive styles, Witkin, et.al. (1954) found that females as a group tend toward a global or contextual approach in perceptual and intellectual functioning, whereas males tend toward the analytical approach. That is, females are more field dependent, they cling to the external context of a perceptual situation and are more influenced by misleading cues. It has also been found that spatial mechanical ability is less well-developed in females and that this aspect of mathematics becomes increasingly important in high school (Smith, 1964). Clearly, early levels of arithmetic emphasize skills in rote memorization and computation (in which the sexes do not differ), while later levels of mathematics involve more spatial and abstract skills.

A more social-psychological explanation of the sex difference in mathematical ability has been developed by Milton (1957). He suggested that the feminine role in society has traditionally been more verbal while the masculine role has been more quantitative--consequently, different cognitive skills are developed. Along this same line, Carlsmith (1964) saw modeling of the same-sex parent as the root of the differential quantitative ability which develops in adolescence--mothers are more verbal generally, fathers are usually better at quantitative tasks. Carrying this a step further, Bieri's (1960) study of undergraduate women and Plank and Plank's (1954) study of the autobiographies of outstanding women mathematicians found that analytical ability was strongly associated with a high level of identification with, and a strong attachment to, fathers rather than mothers. Similarly, Feierabend (1960) concluded that

interest and ability in mathematics were a consequence of masculine identification.

Lynn (1972) tied sex-role identification to differential mathematical ability somewhat differently. Accordi.g to Lynn, there are two types of learning tasks: the "problem", in which the learner must first explore the situation and determine the goal, and the "lesson", in which the exploration and goal-setting stages are minimized and learning comes about through memorizing what is presented. These two roughly parallel male and female sex-role learning. The female model (mother) is generally present in the early development years from which the female may imitate or memorize her appropriate role. The male model (father) on the other hand, is generally absent during much of this development stage. The male child must solve the male role "problem" from largely negative admonishments and must restructure these and define the masculine role as his goal. Relating this to mathematical abilities, the "lesson" for females and the "problem" for males in their appropriate sex-role development results in reinforcement of memorization skills in girls and problem-solving skills in boys.

Several studies suggest that cultural differences in independence training account for differences in mathematical abilities between males and females. For example, Berry (1966) found that there were no differences in spatial ability among Eskimo males and females. On the other hand, studies in the United States indicate that males tend to be superior to females in spatial abilities (see Maccoby, 1966). MacArthur (1967) replicated these results in his own test of two other populations of Eskimos. Both studies noted that Eskimo girls and women are very independent compared to our culture's definitions of female roles; and other research cites a link between independence training and development in spatial abilities (Munroe and Munroe, 1971).

Along this line, Minuchin, et.al. (1969) found that girls in contemporary schools did much better in tests of spatial ability than girls from traditional schools. In support of the influence of culture on sex differences, Svensson's (1971) study of Swedish students (where a high emphasis is placed on sex equality) failed to find these sex differences in mathematical ability that are typical of United States studies.

Of course, there are additional socio-cultural explanations for sex differences in mathematics. For example, Aiken (1972) found that a positive attitude towards mathematics was highly correlated with problem solving ability and that this attitude was associated with sex. It has also been found that females avoid mathematics because it is viewed as a male subject and may serve to "defeminize" them (Elton and Rose, 1967). This becomes particularly notable at adolescence when the divergence of the two sex roles is more apparent and socially important. It should be noted that these emergent attitudes emerge with the age when males begin to show higher skill attainments in mathematics than females.

Furthermore, the development of attitudes opposed to mathematics is associated with socialization practices in school. For example, Howe (1971) found that teachers assume that girls are likely to love reading and to hate mathematics and science. ". . .members of each sex are encouraged in and become interested in and proficient at, the kinds of tasks that are most relevant to the roles they fill currently or are expected to fill in the future" (Maccoby, 1966:40).

A conclusion that socio-cultural forces are important leads to an examination of the influence of parents who are usually the primary agents for enculturation and socialization. Brookover and Erickson (1975), upon reviewing the research literature, noted that differences in expectations for males and females

as students in mathematics are widely recognized. For example, Poffenberger and Norton's (1963) study of college students found that parents' achievement expectations in college algebra were higher for males than for females, and Luszki and Schmuck (1965) found that boys perceived more pressure from parents for academic achievement than did girls. In addition, Aiken and Dreger (1961) found that parents' emphasis and encouragement in mathematics is more relevant for females' attitudes towards mathematics than for males. This suggests the special importance of parental expectations for females' achievement behavior. Having low parental evaluations of one's mathematical ability would be a deterrent to both taking advanced high school mathematics courses and to one's mathematical performance (Sells, 1973). In summary, one may anticipate with some confidence, that parental evaluations, student self-concepts of mathematical ability and student entry into mathematics classes are related (Brookover, et.al., 1962; Backman, 1970; Poffenberger and Norton, 1963). As a consequence, certain of the differences in career outcomes which depend in part on mathematics skills may be traced back to the evaluations of ability provided by parents.

The purposes of this research are to examine the possible causal linkages between perceived parental evaluations, self-concept and taking twelfth grade mathematics, controlling for the influence of sex, IQ, and SES. A causal model is employed using path analysis which indicates both the direct effects of sex on taking mathematics and the indirect effects of sex through the intervening variables of parental evaluations and student self-conceptions of mathematical ability.

Additional questions which guided this study were: What are the direct and indirect relationships between sex and taking mathematics controlling for intelligence and social class? Illustrative of our questions were: How do

males and females compare with respect to taking mathematics at each parental evaluation response level? Do females tend to have lower self-conceptions of their mathematical ability than do males? How do males and females compare with respect to taking twelfth grade mathematics for low, average and high mathematical self-concept students?

Methods

In order to answer the above questions, longitudinal data, 8th grade though 12th grade, were obtained on a single cohort of 558 subjects, 255 males and 303 females, in one large midwestern city, who are currently about age 28. We were interested in this initial study in what we perceived as possible causes of apparent differences in proportions of males and females at this age level entering higher career levels. Fortunately, data were available concerning parental evaluations of their mathematical abilities in the 8th grade and whether they completed 12th grade courses in mathematics. In addition, data were available on the subjects' intelligence and socio-economic status.

The data on parental evaluations of mathematical ability and students self-conception of mathematical ability were obtained using scales which were validated by Brookover and associates (1967). The parental evaluation instrument called for students to make responses to questions asking for their perceptions of how their parents evaluated their mathematics skills. Data on the subjects' intelligence, sex, socio-economic status (coded according to the Duncan scale) and mathematics courses completed were taken from school records.

Our examination of the data is based on path analysis models (Loether and McTavish, 1974) and percentages which describe differences between male and female subjects.

Findings

As shown in Table 1, it appears that being female may have a general deterrent effect on taking 12th grade mathematics. While one third of all students completed mathematics, the separate male and female percentages differed considerably--53 percent of the males but only 17 percent of the females did. The ratio of over 3 males to 1 female tend to persist even when controls for ability are introduced.

Table 1.--Percentages of males and females who completed twelfth grade mathematics in relation to general intelligence quotient level (IQ).

Completed Mathematics Course	All Students		Low IQ		Average IQ		High IQ	
	M	F	M	F	M	F	M	F
Yes	53%	17%	36%	11%	53%	13%	69%	26%
No	47	83	64	89	47	87	31	74
Total	100	100	100	100	100	100	100	100
(Total N)	(255)	(303)	(84)	(96)	(74)	(115)	(97)	(92)

Comparing males with females at each SES level, a much higher percentage of males than females completed mathematics in the twelfth grade as shown in Table 2. The male-female ratios of the proportions who did take mathematics for each SES group were all 3 to 1 or higher in the males' favor. Further, although social class appears to be related to taking twelfth grade mathematics, nearly twice as many of the lowest SES males took mathematics as compared with the highest SES females (42% to 23%).

Table 2.--Percentages of males and females who completed twelfth grade mathematics in relation to social class (SES).

Completed Mathematics Course	Lowest SES		Second SES		Third SES		Highest SES	
	M	F	M	F	M	F	M	F
Yes	42%	14%	47%	11%	56%	16%	69%	23%
No	58	86	53	89	44	84	31	77
Total	100	100	100	100	100	100	100	100
(Total N)	(72)	(69)	(57)	(79)	(64)	(74)	(62)	(81)

Focusing now on the influence of parental evaluations and self-concept, tables three through six show their relationship to sex and the taking of twelfth grade mathematics. Table 3, gives the response distribution as to where the students thought their parents would rank their mathematical ability.

Table 3.--Distribution of perceived parental evaluation of mathematical ability responses for males and females: 8th grade.

Perceived Evaluation Response	Male		Female	
	%	N	%	N
Among the Poorest	0	0	0	0
Below Average	1	2	2	5
Average	8	20	12	35
Above Average	33	83	40	120
Among the Best	59	150	47	143
Total	101	255	101	303

Even as early as the eighth grade, far more males than females perceived that their parents judged their mathematical capability to be among the best (59% vs. 47%). Females were more likely to perceive average or above average mathematics evaluations than males. Very few students perceived evaluations of their mathematical ability to be below average.

Within these response categories, the percentages of males and females who completed the twelfth grade mathematics course can be seen in Table 4.

Table 4.--Percentage of males and females who completed twelfth grade mathematics in relation to 8th grade perceived parental evaluation of mathematical ability.

Completed Mathematics Course	Perceived parental evaluation of mathematical ability							
	Below Average		Average		Above Average		Among the Best	
	M	F	M	F	M	F	M	F
Yes	0%	0%	30%	6%	43%	13%	63%	23%
No	100	100	70	94	57	87	37	77
Total	100	100	100	100	100	100	100	100
(Total)	(2)	(5)	(20)	(35)	(83)	(120)	(150)	(143)

There appears to be a clear relationship between perceived evaluations of mathematical ability and taking mathematics for both males and females. For both sexes, there was a notable increase in the proportion who completed twelfth grade mathematics for each consecutively higher parental evaluation response. The male-female differences were even more striking, however. In the "Average" category, the male-female ratio of the proportions who completed mathematics was 5 to 1; in the "Above Average" category it was over 3 to 1; and in the "Among the Best" category it was also nearly 3 to 1. In fact, proportionally, there were even more average males taking mathematics than females from the highest evaluation category (30% to 23%). It is also surprising that of the females whose parents considered them to be among the best in mathematics, less than a quarter completed twelfth grade mathematics. There is, of course, a four year difference in the measurement of variables. And these high evaluations may have decreased by the twelfth grade.

Dividing the students into low, average and high self-concept groups,

Table 5 shows that males and females differed considerably as to their self-concepts of their mathematical ability even in the eighth grade.

Table 5.--Distribution of self-concept of mathematical ability responses for males and females: 8th grade.

Self-Concept	Male		Female	
	%	N	%	N
Low	28	73	39	119
Average	29	73	33	99
High	43	109	28	85
Total	100	255	100	303

Comparing males and females in Table 5, indicates that many more males than females (43% to 28%) judged their mathematical ability to be "high", that is, falling into the top third of the class. The greatest proportion of females (39%) judged their mathematical ability to be "low", that is, in the lowest third of the class on self-concept, while the greatest proportion of males judged their ability to be "high."

The proportion of males and females within each self-concept level who completed twelfth grade mathematics is shown in Table 6.

Table 6.--Percentage of males and females who completed twelfth grade mathematics in relation to their 8th grade self-conceptions of mathematical ability.

Completed Mathematics Course	Low SCMA		Average SCMA		High SCMA	
	M	F	M	F	M	F
Yes	34%	11%	56%	14%	64%	27%
No	66	89	44	86	36	73
Total	100	100	100	100	100	100
(Total N)	(73)	(120)	(73)	(98)	(109)	(85)

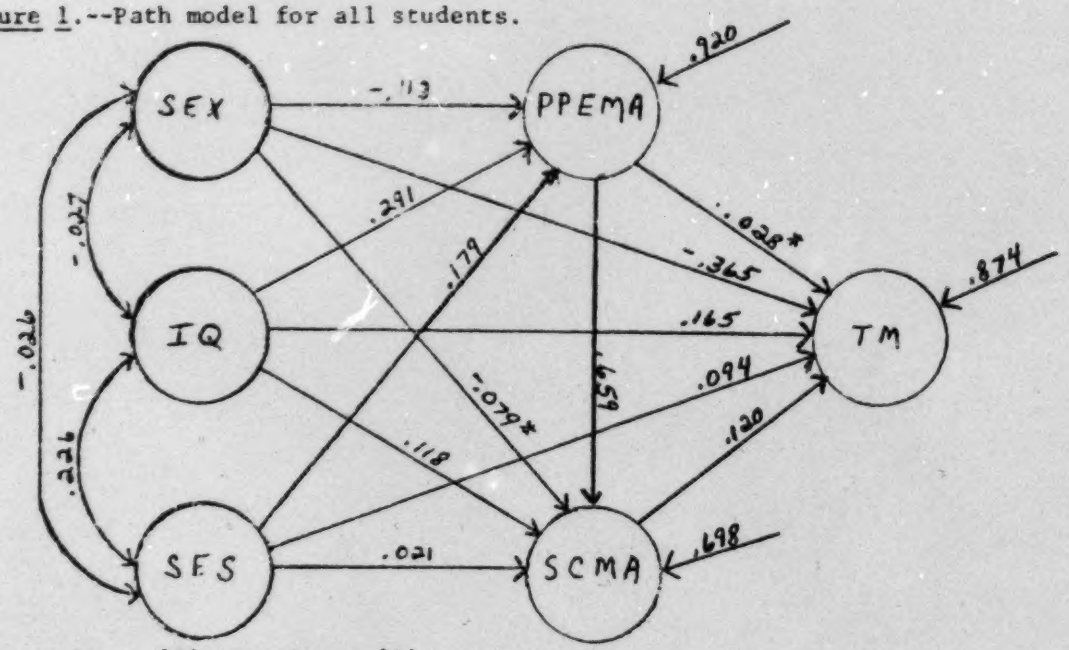
An examination of Table 6 shows that self-concept of mathematical ability was related to taking mathematics for both sexes. A greater proportion of high SCMA students completed twelfth grade mathematics as compared with the average group, and a greater proportion of the average SCMA students took mathematics when compared to the low SCMA group. However, for females, the average group did not differ very much from the low self-concept group. For males, the percentage who completed twelfth grade mathematics in the average group was much more similar to the percentage in the high self-concept group.

Comparing males to females, for all three self-concept groups, a much higher proportion of males than females completed twelfth grade mathematics. For those students in the lowest third of the class on SCMA, the male-female ratio of the proportions taking mathematics was 3 to 1; for the average group, the ratio was 4 to 1; and for the top third of the class, the ratio was over 2 to 1. In fact, proportionally, more low self-concept males completed twelfth grade mathematics than did high self-concept females.

In order to look at the direct and indirect effects of sex on taking mathematics, path analysis was used (See Figure 1). IQ and SES are included in the model as well as the two intervening variables of concern: perceived parental evaluation of mathematical ability and self-concept of mathematical ability. The multiple correlation coefficient for these variables is .486, hence the five independent variables together explain 24% of the variance in taking mathematics.

The model shown in Figure 1 does give somewhat large weights for the error terms and likewise somewhat small path coefficients as might be expected from a simple model as this. The time difference between the measurement of the predictor variables in the 8th grade and the dependent variable in the 12th grade also causes some loss of predictive power. For example, other intervening

Figure 1.--Path model for all students.



Sex: Males: '0', Females: '1'
PPEMA: Perceived parental evaluations of mathematical ability
SCMA: Students' self-conception of mathematical ability
TM: Completed mathematics courses in 12th grade (No: '0', Yes: '1')

*Beta weights are less than twice the coefficient's standard error.

variables not measured here, such as the parental evaluations occuring during the 9th, 10th and 11th grades may have explained more of the variance in the taking of mathematics in the twelfth grade. In addition, the model did not include other variables which would, no doubt, be important in the decision-making process such as the instrumental and intrinsic values to females in taking mathematics. For these reasons, what may appear to be relatively small predictive weights are actually large enough to be considered substantively as well as statistically significant.

In comparing the direct effects of each independent variable on the dependent variable, the weight of the path from sex to taking courses in mathematics (TM) (-.365) was notably heavier than any of the others. This negative weight indicates that being female had a direct depressant effect on whether

one completed mathematics in the twelfth grade. This should not be interpreted as simply the result of ones biological sex. Rather, the sex variable encompasses a cluster of social factors in addition to parental evaluations of mathematical ability which may be working against females completing twelfth grade mathematics.

The three indirect paths from sex to TM (Sex--SCMA--TM, Sex--PPEMA--SCMA--TM, Sex--PPEMA--TM) all followed the same negative direction as the direct effect discussed above. Note first the path from sex to SCMA to TM: self-concept of mathematical ability in the eighth grade was positively related (.120) to taking mathematics in the twelfth grade. However, sex was somewhat negatively related to SCMA (-.079). Thus, this indirect path would indicate that, in addition to the above direct depressant effect which sex had, females were somewhat less likely to take mathematics because of lower self-concepts of their mathematical ability.

There was a stronger indirect depressant effect on the path from sex through PPEMA through SCMA to TM. Here again, there was a positive path from PPEMA to SCMA (.659), and likewise from SCMA to TM (.120). But there was also a negative path from sex to PPEMA (-.113). From this, having higher parental evaluations, one would predictably have a higher self-concept of mathematical ability and would be more likely to take twelfth grade mathematics. But females perceived lower parental mathematical evaluations and, hence, were less likely to take mathematics along this indirect path.

Hence, sex had a depressant effect on taking mathematics both directly and indirectly with the direct path having the heaviest weight. The third indirect path from sex to TM through PPEMA alone was also to females' disadvantage but was not significant because of the relatively small beta weight between PPEMA and TM which was also not twice its standard error. This would follow the theoretical model in which self-concept is the intervening variable

between expectations and behavior rather than expectations having a direct effect on behavior.

IQ and SES both were influential in whether the student completed twelfth grade mathematics or not, both directly and indirectly. Both had their strongest positive weights on their paths to PPEMA and, thus, affected TM indirectly through SCMA. IQ also had a somewhat large weight on its direct path to TM; SES had somewhat less direct effect.

When additional path models were run for males and females separately, the main additional finding was the difference in path weights between the variables PPEMA and SCMA. For females this weight was .712, for males it was .613, indicating that parental evaluations were even more important for influencing females' self-concept of their mathematical ability than for males.

Discussion

The primary concern of this research was to examine whether fewer females than males completed mathematics in the twelfth grade because of parental influence. This study indicated that perceived parental evaluations of a student's mathematical ability had an important impact and that these parental evaluations were related to sex, when ability and social class were taken into account. Furthermore, parents seemed to have a greater impact through their evaluations on their daughters' self-conceptions of their mathematical ability than their sons'. This suggests that perceiving low mathematical evaluations from parents would be even more harmful to females than males with respect to completing twelfth grade mathematics.

But the analysis of the path model also indicated that sex had a direct negative effect on taking twelfth grade mathematics. What other latent or apparent social factors does the variable sex encompass? For example, are there academic "significant others" besides parents who hold low mathematical

evaluations for females as teachers and peers? Perhaps there is a consensus of evaluations--a norm that females must take into account in their decisions to take mathematics. In addition, females may have learned to attach differing instrumental and intrinsic values to mathematics than males and these conditions too may affect the decision to take higher mathematics. Even though answers to these questions are conjectural at this point, such answers might explain some of the variance in taking mathematics over and above the variance accounted for in this study.

However, the overriding problem being addressed in this research has to do with why today's adult women are stereotyped as being inferior to men in mathematics. Although the stereotype may somewhat reflect the situation as it has been and perhaps as it presently exists, it certainly does injustice to what is possible for females. This study has very definite implications for correcting the status of women. If parents are taught to communicate higher evaluations of their daughters' mathematical ability, more females will choose to take advanced mathematics courses and consequently improve their mathematical abilities and thereby, their life chances.

It should also be emphasized to the entire public that even if one does not choose mathematics as an area of specialization, advanced high school mathematics training is important for its contribution to the general development of one's logic, efficiency, abstract and quantitative reasoning skills, computational abilities and problem-solving abilities and perhaps more important for most are the career consequences of attaining mathematical skills. Performance on general intelligence, college readiness and graduate school tests or performance on civil service and job aptitude examinations--all of which have many questions measuring mathematical abilities--is influenced by skill in mathematics. Non-mathematics fields such as psychology, sociology, social

work, business and yes, even the arts, commonly require minimal mathematics skills in order to get into graduate or professional school. Women who do poorly on entrance exams can be easily excluded from advanced training. Such is the influence of early training in mathematics. Many other college curriculums are obviously closed to those students without appropriate prior mathematics training since majors such as engineering, physics, chemistry, statistics, computer programming and other technical fields may require beginning calculus classes (which start at a level presupposing the student has successfully completed four years of high school mathematics). Thus, taking courses in mathematics in high school is more than a matter of interest in the field. It is a matter of equality.

This research leaves many unanswered questions concerning females and their mathematical abilities. Probably the most relevant question we have addressed is whether the same situation for our subjects will still be prevalent in the next generation. One might guess that the current emphasis on eliminating sexism in the schools, and in society in general, has altered the situation. However, have sexist supporting beliefs among parents also been altered? We doubt it. There is still a far greater proportion of males than females taking mathematics courses. One would hope that there has been an improvement in family socialization in the last fourteen years but we expect that it has been minimal particularly with regard to sexual stereotypes about mathematics. For example, Sells found that ninety-two percent of the entering women in the Fall of 1972 at Berkeley did not qualify for freshman calculus on the basis of insufficient preparation.

In any event, this research lends further support to socio-cultural explanations for observed sex differences in mathematics. This study looked at today's twenty-eight year olds when they were in high school and earlier. We

conclude that the reason today's adult women are considered inferior in mathematics is at least partially due to their parent's evaluations of their mathematical abilities when they were children.

If more females are to take higher mathematics, there is a need to improve the self-conceptions of mathematical ability of females. This can be accomplished through improving the evaluations that parents hold for their daughter's mathematical potential. Researchers have provided strategies for enhancing parental evaluations and thereby enhancing students' self conceptions of mathematical ability and mathematics achievement (Brookover and Erickson, 1975).

Perhaps strategies of this sort may help to improve the status of women in the up-coming generation of females who are still in their career preparation stages. But additionally, perhaps effort should be placed on improving the mathematical self-images of the adult women of today who have already passed through the type of educational and family systems we have described here. Further strategies aimed at improving the public image of females as portrayed by the entertainment, information-giving and advertising media could be a point of focus. The media should convey an image of women as competent and the consequences to them of false stereotypes. Even though considerable overt discrimination may be ended, the residual unconscious effects of past discrimination against women may continue through false beliefs. Unfortunately, these false beliefs about the inferior mathematical aptitudes of women may maintain women in a subordinate role in our culture for many years to come.

REFERENCES

Aiken, L. R. 1972. "Research on Attitudes Toward Mathematics." Arithmetic Teacher 19 (March): 229-34.

Aiken, L. R. and R. M. Dreger. 1961. "The Effects of Attitudes on Performance in Mathematics." Journal of Educational Psychology 52: 19-24.

Backman, Alfred M. 1970. "The Relationship Between a 7th Grade Pupils Academic Self-Concept and Achievement in Mathematics." Journal of Research in Mathematics Education 1 (May): 173-9.

Bem, Sandra and Daryl Bem. 1970. "We're All Nonconscious Sexists." In Beliefs, Attitudes and Human Affairs by Daryl J. Bem. Monterey, California: Brooks/Cole.

Berry, John W. 1966. "Femininity and Eskimo Perceptual Skills." International Journal of Psychology 1:3: 207-29.

Bieri, J. 1960. "Parental Identification, Acceptance of Authority, and Within-sex Differences in Cognitive Behavior." Journal of Abnormal Social Psychology 60: 76-9.

Brookover, Wilbur, Ann Paterson and Shailer Thomas. 1962. Self-Concept of Ability and School Achievement I. Cooperative Research Project No. 845. East Lansing: Office of Research and Publications, Michigan State University.

Brookover, Wilbur and Edsel Erickson. 1975. Sociology of Education. Homewood: Illinois: The Dorsey Press.

Brookover, Wilbur, Edsel Erickson and Lee Joiner. 1967. Self-Concept of Ability and School Achievement III. Cooperative Research Project No. 2831. East Lansing: Human Learning Research Institute, Michigan State University.

Carlsmith, L. 1964. "Effect of Early Father Absence on Scholastic Aptitudes." Harvard Educational Review 34: 3-21.

Elton, C. F. and H. A. Rose. 1967. "Traditional Sex Attitudes and Discrepant Ability Measures in College Women." Journal of Counseling Psychology 14: 538-43.

Feierabend, R. L. 1960. "Review of Research on Psychological Problems in Mathematics Education." In Research Problems in Mathematics Education. U. S. Office of Education Coop. Res. Mono. #3: 3-46.

Fennema, Elizabeth. 1973. "Mathematical Learning and the Sexes: A Review." Paper presented at the annual meeting of the American Educational Research Association (February).

Flannigan and associates. 1964. The American High School Student. Pittsburgh: Project Talent Office, University of Pittsburg.

Forbes, Roy H. 1975. "Learning: Why Do Boys Do Better?" Time (October 27): 60.

Hilton, T. L. and G. W. Berglund. 1974. "Sex Differences in Mathematics Achievement--a Longitudinal Study." Journal of Educational Research 67 (January): 231-7.

Howe, Florence. 1971. "Sexual Stereotypes Start Early." Saturday Review 54 (October): 76-7.

Jacklin, Carol Nagy and Eleanor Maccoby. 1972. "Sex Differences in Intellectual Abilities: A Reassessment and a Look at Some New Explanations." Paper presented at American Educational Research Association.

Kaminski, Donna M. 1974. "The Effect of Perceived Parental Evaluations on Skills Development in Mathematics." Unpublished master's thesis, Western Michigan University, Kalamazoo, Michigan.

Lewis, Edwin C. 1968. Developing Woman's Potential. Ames, Iowa: Iowa State University Press.

Loether, Herman J. and Donald G. McTavish. 1974. Descriptive Statistics for Sociologists. Boston: Allyn and Bacon.

Luszki, Margaret Barron and Richard Schmuck. 1965. "Pupil Perceptions of Parental Attitudes Toward School." Mental Hygiene IL:2: 296-307.

Lynn, David B. 1972. "Determinants of Intellectual Growth in Women." School Review 80 (February): 241-60.

MacArthur, Russell. 1967. "Sex Differences in Field Dependence for the Eskimo." International Journal of Psychology 2:2: 139-40.

Maccoby, Eleanor E. (Ed.). 1966. The Development of Sex Differences. Stanford, California: Stanford University Press.

Milton, G. A. 1957. "The Effects of Sex-role Identification upon Problem Solving Skill." Journal of Abnormal Social Psychology 55: 208-12.

Minuchin, Patricia, Barbara Biber, Edna Shapiro, and Herbert Zimilies. 1969. The Psychological Impact of School Experience. New York: Basic Books.

Munroe, R. and R. H. Munroe. 1971. "Effect on Environmental Experience on Spatial Ability in an East African Society." Journal of Social Psychology 83: 15-22.

Osborne, R. T. and Wilma B. Sanders. 1954. "Variations in Graduate Record Exam Performance by Age and Sex." Journal of Gerontology 9: 179-85.

Plank. E. N. and C. Plank. 1954. "Emotional Components of Arithmetical Learning as seen through Autobiographies." Psychoanalytic Studies of the Child 9: 274-9.

Poffenberger and Norton. 1963. "Sex Differences in Achievement Motivation in Mathematics as Related to Cultural Change." Journal of Genetic Psychology 103: 341-50.

Rosenberg, B. G. and B. Sutton-Smith. 1964. "The Relationshio of Ordinal Position and Sibling Sex Status to Cognitive Abilities." Psychological Science 1: 81-2.

Rossi, Alice. 1969. "Women in Science: Why so Few?" In Achievement in American Society. Cambridge, Massachusetts: Schenckman Publishing Company.

Sells, Lucy W. 1973. "High School Mathematics as a Critical Filter in the Job Market." ERIC, ED080351 (March).

Sells, Lucy W. 1976. "Mathematics, Minorities and Women." Footnotes American Sociological Association 4:1: 1 (January).

Sheehan, L. 1968. "Patterns of Sex Differences in Learning Mathematical Problem Solving." Journal of Experimental Education 36:1: 84-7.

Smith, M. I. 1964. Spatial Ability. London: University of London Press.

Svensson, Allan. 1971. Relative Achievement - School Performance in Relation to Intelligence, Sex and Home Environment. Stockholm: Almquist and Wiksell.

U. S. Department of Health, Education and Welfare. 1971. "Earned Degrees Conferred: 1970-71." Washington, D.C.: Office of Education.

Witkin, H. A., Helen B. Lewis, M. Herzman, Karen Machover, Pearl B. Meissner and S. Wapner. 1954. Personality through Perception. New York: Harper.